

# Energy Sector Development in Africa\*

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## 1. Introduction

The important and wide-ranging role of energy in the development process is well known and it needs no retelling here. However, suffice it to state that there is a strong feedback relationship between the energy sector and the national economy. Energy demand, supply and pricing have enormous impact on social and economic development and the living standards and overall quality of life of the population. On the other hand the economic structure and the changes in that structure as well as the prevailing macroeconomic conditions are key determinants of energy demand and supply. Furthermore, energy affects environmental quality through deforestation associated with unsustainable biomass energy dependence and greenhouse gas emission from fossil fuel use resulting in global warming.

Prior to 1973, the rate at which energy consumption increased closely followed the rate at which the economy expanded. Rapid economic growth and steadily rising income and higher living standards combined with the long term declining trend in energy prices to produce rapidly rising global energy demand. Until the emergence of the high cost energy era in the post 1973 era, relatively cheap and abundant energy was a key feature of rapid industrialization and economic progress. Indeed, commercial energy use remains a key factor in human development. This is despite the global de-coupling of energy demand-economic growth relationship in the post – 1970 period, triggered by the onset of a new era of more expensive energy associated with the quadrupling of oil price increases between 1973 and 1974, and further price escalation in 1979 and 1980.

Beyond the low level of energy consumption per capita, and unsustainable over-dependence on bio-mass (wood-fuel), Africa is faced with enormous problems in the quest for sustainable energy development. For the purpose of addressing these problems effectively, we can summarize the fundamental energy question facing Africa as: providing and maintaining widespread access of the population to reliable and affordable supplies of environmentally cleaner energy to meet the requirements of rapid economic growth and improved living standards. Two sets of factors complicate the solutions to this critical question. First is the difficult initial energy and economic conditions in much of the region. These are broadly defined by the significant deterioration in energy infrastructure, inadequate and unreliable supply of commercial energy to end users despite the enormous untapped energy resources in the region, and significant inefficiency in energy use. The energy constraints have been exacerbated by difficult domestic economic and social conditions. These are defined broadly

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by, low per capita income, high incidence of poverty, weak economic growth and growth collapse in several cases, stagnating or declining investment (energy inclusive) and weak though improving domestic macroeconomic conditions, social conflict and weak governance in public enterprises in charge of energy. Second, there is the global pressure driven by sustainable human development to tackle the increasingly significant adverse local, regional and global environmental impact of energy sector development. This will accelerate the demand for cleaner energy and the associated energy resource development. The search for a sustainable energy sector development will therefore remain an important issue in Africa as well as in the rest of the world. The paper presents a broad but systematic discussion of the main issues concerning sustainable energy development in Africa.

The structure of the paper is as follows. In section 2 the socio-economic context of the problem is discussed. In section 3 we present an overview of the developments in the energy sector in the post 1970 period with emphasis on the sub-regional perspective. This is followed by an analysis of the constraints to energy sector development in section 4. The paper explores some of the key issues and strategies for achieving the goal of sustainable energy development in Africa in section 5. The conclusions are presented in section 6.

## **2. The Social and Economic Context of the Energy Question**

Of particular interest in dealing with the energy question is the current social and economic characteristics and changes in socio-economic conditions in African countries in recent decades. This would situate energy sector development in its social and economic setting. The discussion in the following section draws upon selected social and economic indicators to illuminate important energy implications of recent social and economic development in their region.

### ***Social and Demographic Overview***

The social and demographic data presented in table 1 reveal several observations of great significance for economic growth and energy development. In general, despite some social and demographic diversity among the 53 countries in the region, there are a number of broad similarities. Most African countries are sparsely populated with a population density of less than 80 people per square kilometer. Mauritius, Rwanda, and Burundi, all small countries population-wise, are the main exceptions. Among the large economies in the region, Nigeria with a density of 122 people per square kilometer, is a major exception. Also, the demographic trends describe a commonly striking regional feature of rapid population growth rates, at an average annual rate of about 3 per cent during the previous two decades. Africa's population growth is the fastest in the world (National Research Council; 1993, United Nations; 1996). In addition, the population structure is dominated by young people, and the high dependency rate imposes immense pressures on slim household resources. Despite the slow down in the population growth rate in recent years, the absolute population level is expected to double in about thirty years. Over two-thirds of the population in the region lived in the rural areas by the mid-1990s (Table 1). The large proportion of rural population contrasts sharply with what obtains in the more industrialized countries where the urban population constitutes more than 70 percent of the total population.

Urbanization rate is relatively low in Africa compared to other regions. However, of greater policy significance is its rate of change, which has been the most dramatic globally in the past three decades. In many countries, urban population growth was above 6 per cent. The rapid rate of urbanization in the post-independent period was largely triggered by rising impoverishment of the rural areas arising from the large net resource transfers from the rural to urban areas, and the perceived higher income earning potentials in the urban areas (Oberai; 1987). But, there has been a noticeable slow down in the urbanization rate in the post-SAP period. It is associated with a reversal in rural-urban terms of trade in favor of the rural economy due mainly to the effects of recent economic reforms and the relatively more severe impact of recent economic crises on the urban economy compared to the rural economy.

A demographic trend characterized by rapid population growth, rapid urbanization rate, and low population density would have significant impact not only on future energy demand and supply patterns and the efficient delivery of energy to consumers, but also on the strategy of energy development. Rapid urbanization rate combined with steady economic growth is likely to accelerate the energy transition from traditional to commercial energy use. Yet, the prevailing economic environment discussed later, and the emergence of a more deregulated domestic energy market characterized by a substantial rise in the prices of commercial fuels, are likely to continue to exert strong pressures on many households in both urban and rural areas, to rely more on traditional fuel sources such as charcoal and fuel-wood. It is common knowledge that the sharp decline in real income and escalating prices of modern energy in recent years contributed substantially to many urban households to substitute less expensive traditional fuel for modern energy sources (for example kerosene, gas and electricity) where feasible. The consequent pressure on deforestation and global warming are factors that must be taken into account in the design of development, energy and environmental policy considerations. Obviously, the current rapid population growth and urbanization rate are not sustainable in the medium term given the resource endowment and current level of social and economic development of most African countries. The demographic characteristics and conditions are bound to exert enormous pressures on the efficient provision of adequate energy supplies to meet energy consumption and also on environmental quality especially in the urban areas. The fact that many of the countries in the region are land-locked, adds another dimension to the region's energy problem given the impact of the transport factor on the delivered cost of imported energy on which most of the countries in the region are dependent. Increasing the capacity of the urban economy to contend with the emerging demographic trends in terms of creating rapidly increasing employment opportunities and incomes, and also adequate provision of urban services including energy, remains a major challenge to sustainable development in Africa.

### ***The Economic Context of Energy Sector Development in Africa***

The basic characteristics and performance record of Africa are summarized in Tables 1 through 4. Despite the heterogeneity in the region, taken together the available data describe a striking broadly similar economic trends and conditions. These similar features frame the boundaries for addressing Africa's complex energy problems. Africa's economic problems are of crisis proportions

**Table 1: Socio-Economic Indicators in Africa, 1980 and 1995.**

	1980					1995				
	Popula- tion (Millions)	Popula- tion Density (per sq. km)	Land Area (*000 of sq. km)	% of Urban Popula- tion	GNP Per Capita	Popula- tion (Millions)	Popula- tion Density (per sq. km)	Land Area (*000 of sq. km)	% of Urban Popula- tion	GNP per Capita
<b>North Africa</b>										
Algeria	19	8	2382	43	2080	28	12	2382	56	1590
Egypt	41	41	995	44	530	58	58	995	44	990
Libya	3	2	1760	70	10460	5	3	1760	86	
Morocco	19	43	446	41	990	30	66	446	44	1110
Sudan	19	8	2376	20	430	27	11	2376	26	
Tunisia	6	41	155	51	1360	9	58	155	57	1820
<b>Total</b>	<b>107</b>		<b>8114</b>			<b>157</b>		<b>8114</b>		
<b>Average</b>	<b>18</b>	<b>24</b>	<b>1352</b>	<b>45</b>	<b>2642</b>	<b>26</b>	<b>35</b>	<b>1352</b>	<b>52</b>	<b>1378</b>
<b>W. Africa</b>										
Benin	3	31	111	32	410	5	49	111	42	360
Burkina Faso	7	25	274	9	250	10	38	274	27	210
Cote d'Ivoire	8	26	318	35	1290	14	44	318	44	620
Gambia	1	64	10	18	370	1	111	10	26	320
Ghana	11	47	228	31	430	17	75	228	36	350
Guinea	4	18	246	19		7	27	246	30	540
Guinea Bissau	1	29	28	17	140	1	38	28	22	240
Mali	7	5	1220	19	250	10	8	1220	27	250
Mauritania	2	2	1025	29	470	2	2	1025	54	460
Niger	6	4	1267	13	480	9	7	1267	23	200
Nigeria	71	78	911	27	790	111	122	911	39	220
Senegal	6	29	193	36	540	8	44	193	42	530
Sierra Leone	3	45	72	25	370	5	63	72	36	170
Togo	3	48	54	23	440	4	76	54	31	300
<b>Total</b>	<b>131</b>	<b>452</b>	<b>5955</b>	<b>331</b>	<b>6230</b>	<b>205</b>	<b>705</b>	<b>5955</b>	<b>479</b>	<b>4770</b>
<b>Average</b>	<b>9</b>	<b>32</b>	<b>425</b>	<b>24</b>	<b>479</b>	<b>15</b>	<b>50</b>	<b>425</b>	<b>34</b>	<b>341</b>
<b>Central Africa Rep.</b>										
Burundi	4	161	26	4	200	6	244	26	8	160
Cameroon	9	19	465	31	700	13	29	465	45	570
Central Africa Rep.	2	4	623	35	340	3	5	623	39	350
Chad	4	4	1259	19	170	6	5	1259	21	160
Congo Brazz.	2	5	342	41	890	3	8	342	59	630
Congo DRC	27	12	2267	29	640	44	19	2267	29	110
Equatorial Guinea	0	8	28	27		0	14	28	42	380
Gabon	1	3	259	36	4750	1	4	259	50	3490
Rwanda	5	209	25	5	250	6	259	25	6	180
<b>Total</b>	<b>54</b>	<b>423</b>	<b>5293</b>	<b>227</b>	<b>7940</b>	<b>84</b>	<b>588</b>	<b>5293</b>	<b>299</b>	<b>6030</b>
<b>Average</b>	<b>6</b>	<b>47</b>	<b>588</b>	<b>25</b>	<b>993</b>	<b>9</b>	<b>65</b>	<b>588</b>	<b>33</b>	<b>670</b>
<b>East Africa</b>										
Ethiopia	38			11		56			14	110
Kenya	17	29	569	16	450	27	47	569	28	280
Somalia	7	11	627	19	100	9	15	627	24	
Tanzania	19	21	884	15		30	34	884	24	130
Uganda	13	64	200	9		19	96	200	12	240
<b>Total</b>	<b>92</b>	<b>125</b>	<b>2280</b>	<b>69</b>	<b>550</b>	<b>141</b>	<b>192</b>	<b>2280</b>	<b>103</b>	<b>760</b>
<b>Average</b>	<b>18</b>	<b>31</b>	<b>570</b>	<b>14</b>	<b>275</b>	<b>28</b>	<b>48</b>	<b>570</b>	<b>21</b>	<b>190</b>
<b>Southern Africa</b>										
Angola	7	6	1247	21		11	9	1247	32	
Botswana	1	2	567	15	940	1	3	567	31	3020
Lesotho	1	45	30	13	440	2	65	30	23	650
Madagascar	9	15	582	18	460	14	23	582	27	230
Malawi	6	65	94	9	190	10	104	94	13	170
Mauritius	1	476	2	42	1240	1	556	2	41	3390
Mozambique	12	15	784	13		16	21	784	38	80
Namibia	1	1	823	23		2	2	823	38	2090
South Africa	29	24	1221	48	2300	41	34	1221	51	3150
Swaziland	1	33	17	18	880	1	52	17	33	1170
Zambia	6	8	743	40	630	9	12	743	45	400
Zimbabwe	7	18	387	22	760	11	28	387	32	540
<b>Total</b>	<b>81</b>	<b>708</b>	<b>6497</b>	<b>283</b>	<b>7840</b>	<b>119</b>	<b>909</b>	<b>6497</b>	<b>403</b>	<b>14890</b>
<b>Average</b>	<b>7</b>	<b>59</b>	<b>541</b>	<b>24</b>	<b>871</b>	<b>10</b>	<b>76</b>	<b>541</b>	<b>34</b>	<b>1354</b>

Source: World Bank African Development Indicators, 1997.

**Table 2: Economic Performance by Period and Region (Annual Average Growth Rates, in Per Cent)**

	1960-73		1973-84		1984-94	
	GDP per worker	TFP	GDP per worker	TFP	GDP per worker	TFP
East Asia (excluding China)	4.2	1.3	4.0	0.5	4.4	1.6
Latin America	3.4	1.8	0.4	-1.1	0.1	-0.4
Middle East	4.7	2.3	0.5	-2.2	-1.1	-1.5
South Asia	1.8	0.1	2.5	1.2	2.7	1.5
Africa	1.9	0.3	-0.6	-2.0	-0.6	-0.4
Non-US industrial countries	4.8	2.2	1.8	0.2	1.7	0.7
US	1.9	0.8	0.2	-0.5	0.9	0.7

Source: Collins and Bosworth (1996).

First, with only a few exceptions, the key economic indicators suggest economic retrogression characterized by a generally low or sharp decline in economic growth (Iwayemi; 1997, ADB; 1997). The combined real Gross Domestic Product (GDP) of the African countries in 1995 was US \$490.3 billion compared to \$370.7 billion in 1980

Second, the economic profile of Africa reveals a substantial regional economic disadvantage. For example, its comparatively small economic size (and this is important for foreign private investment) is illustrated by the size of Africa's economy, as measured by total gross domestic product, being about the size of the Netherlands economy, about one third of the British or Italian economy and about 6 percent of the US economy in 1995 (World Bank; 1997). In marked contrast and for the same year Africa's population is thrice that of the US and forty times that of Netherlands. Table 4 provides additional empirical evidence from a comparative regional perspective to support the earlier interpretation of recent African economic history as dismal. Africa performed poorly as indicated by the growth collapse in the post 1973 period. The region experienced a negative growth in GDP per worker and total factor productivity in the period between 1973 and 1994. South Asia, which recorded similar growth in the golden years of 1960 to 1973, and is similarly poor as Africa, experienced a more steady and positive growth in GDP per worker and total factor productivity in the post 1973 period.

Third, although the relative size of the aggregate African economy is small compared to other regions of the world, there is also the prevalence of small individual economies in the region. Six out of the fifty-three countries in the region produced more than 70 percent of the total gross domestic product in 1995.

Fourth, the average living standards of people in region as measured by the level of per capita real income is quite low as the region's real per capita income (GDP per capita) was only \$600 in 1995. Of greater significance, is the fact that the average real per capita income is less than the poverty threshold of \$370 defined by the World Bank in several countries in the region.

Table 3: Distribution of Gross Domestic Product Value Added (%)

	GDP (Million \$)		Agric.		Indus.		Manufacturing		Services	
	1980	1995	1980	1995	1980	1995	1980	1995	1980	1995
<b>North Africa</b>										
Algeria	42345	41435	10	13	54	47	9	9	36	41
Egypt, Arab Rep.	22913	47349	18	20	37	21	12	15	45	59
Morocco	18821	32412	18	14	31	33	17	19	51	53
Tunisia	8743	18035	14	12	31	29	12	19	55	59
<b>West Africa</b>										
Benin	1405	1522	35	34	12	12	8	7	52	53
Burkina Faso	1709	2325	33	34	22	27	16	21	45	39
Cote d'Ivoire	10175	10069	27	31	20	20	13	18	53	50
Gambia, The	233	384	30	28	16	15	7	7	53	58
Ghana	4445	6315	58	46	12	16	8	6	30	38
Guinea	..	3686	..	24	..	31	..	5	..	45
Guinea-Bissau	105	257	44	46	20	24	..	7	36	30
Mali	1629	2431	61	46	10	17	4	6	29	37
Mauritania	709	1068	30	27	26	30	..	13	44	43
Niger	2538	1860	43	39	23	18	4	..	35	44
Nigeria	93082	26817	27	28	40	53	8	5	32	18
Senegal	3016	4867	19	20	25	18	15	12	57	62
Sierra Leone	1166	824	33	42	21	27	5	6	47	31
Togo	1136	981	27	38	25	21	8	9	48	41
<b>Central Africa</b>										
Burundi	920	1062	62	56	13	18	7	12	25	26
Cameroon	6741	7931	29	39	23	23	9	10	48	38
Central African Rep.	797	1128	40	44	20	13	7	..	40	43
Chad	727	1138	54	44	12	22	..	16	34	35
Congo	1706	2163	12	10	47	38	7	6	42	51
Gabon	4285	4691	7	..	16	..	5	..	33	..
Rwanda	1163	1128	50	37	23	17	16	3	27	46
<b>East Africa</b>										
Ethiopia	5179	5287	56	57	12	10	6	3	31	33
Kenya	7265	9095	33	29	21	17	13	11	47	54
Tanzania	5702	3602	46	58	18	17	11	8	37	24
Uganda	1267	5655	72	50	4	14	4	6	23	36
<b>Southern Africa</b>										
Angola	..	3722	..	12	..	59	..	3	..	28
Botswana	971	4318	13	5	44	46	4	4	43	48
Lesotho	368	1029	24	10	29	56	7	18	47	34
Madagascar	4042	3198	30	34	16	13	..	13	54	53
Malawi	1238	1465	37	42	19	27	12	18	44	31
Mauritius	1132	3919	12	9	26	33	15	23	62	58
Mozambique	2028	1469	37	33	31	12	..	..	32	55
Namibia	2190	3033	12	14	53	29	5	9	35	56
South Africa	78744	136035	7	5	50	31	23	24	43	64
Zambia	3884	4073	14	22	41	40	18	30	44	37
Zimbabwe	5355	6522	14	15	34	36	25	30	52	48

**Table 4: Gross Domestic Investment and Current Account Balance (Percentage of GDP)**

COUNTRY	INV/ GDP		CAB/GDP	
	1980	1995	1980	1995
<b>North Africa</b>				
Algeria	39.1	32.2	0.6	-5.3
Egypt	27.5	16.7	-1.9	2.3
Libya	22.1		23.1	
Morocco	24.2	20.9	-7.5	-4.7
Sudan	15.1		-4.7	-20.1
Tunisia	29.4	24.6	-4	-4.6
<b>W. Africa</b>				
Benin	15.2	19.6	-2.6	-7
Burkina Faso	17	22.2	-2.9	-5.7
Cote d'Ivoire	26.5	15	-17.9	-5
Gambia	26.2	16.2	-37.3	-4.4
Ghana	5.6	18.6	0.7	-2.3
Guinea		14.5		-8.3
Guinea Bissau	29.6	22.3		-16.1
Mali	16.4	26	-8	-6.2
Mauritania	36.2	12.8	-18.9	-1
Niger	36.6	7.5	-10.9	-3.7
Nigeria	22.2	14.7	5.6	-3.7
Senegal	15.3	15.6	-12.8	-4.8
Sierra Leone	17.2	4.8	-15	-17.3
Togo	28.4	14.3	-8.4	-6.3
<b>Central Africa</b>				
Burundi	13.9	7.8	-2.9	-5.7
Cameroon	21	14.5	-5.9	-0.4
Central Africa Rep.	7	14.4	-5.4	-8.2
Chad		17.8	1.2	-12.8
Congo Brazz.	35.8	36	-9.8	-27.1
Congo DRC	10	7.4	-2	-8.2
Equatorial Guinea		17.4		-61
Gabon	27.5	21.2	9	3
Rwanda	16.1	9	-4.1	-3
<b>East Africa</b>				
Ethiopia		16.8		3.3
Kenya	29.2	22.5	-12.1	-4.5
Somalia	42.4		-22.5	-8.4
Tanzania		23		-5.5
Uganda	6	19.7	-6.6	-2.5
<b>Southern Africa</b>				
Angola		13.6		-16.6
Botswana	37.7	24.6	-15.6	7
Lesotho	42.4	78.7	15.2	-32.4
Madagascar	15	10.9	-13.8	-9.7
Malawi	24.7	18.8	-21	-7.8
Mauritius	20.7	30.6	-10.3	-5.6
Mozambique		51.2	-18.1	-33.5
Namibia	29.2	20.5		0.9
South Africa	28.3	18.9	4.5	-2.1
Swaziland	30.3	20.9	-22.3	-4.5
Zambia	23.3	13.9	-13.3	-4.5
Zimbabwe	22.7	23.2	-2.8	-3

Fifth, is the alarming downturn in investment trend. Most of the economies of the region invested an increasingly declining proportion of their GDP between the mid-1970s and mid-1990s (Table 3). The widespread decline in the investment-GDP ratio is vividly illustrated by the fact that a majority of African countries invested less than 20 percent of their GDP in the 1990s compared to a few in the 1970s. This development partly explains the poor economic growth described earlier. Also, the investment-GDP ratio is far below the average for developing countries that ranges between 25 and 35 percent. Prior to recent economic reform programme in the region, low productivity and profitability of public sector investment was the norm. This played an important role in weakening the investment-GDP growth relationship. Recent policy changes including privatization and deregulation measures which are targeted at improving the productivity of investment in the economy are likely to improve substantially the quality of domestic investment and its positive impact on economic recovery and sustained growth.

Sixth, export is dependent on a narrow range of primary products (agricultural and minerals) which have been subject to the familiar problems of market instability and limited demand because of declining global demand and substitution arising from technological development. Adding value to exported goods through manufacturing is a sine qua non for export diversification and sustained export and industrial growth. This certainly has important energy implications. The past decade had been a difficult time for most exporters in Africa as their terms of trade deteriorated sharply. Primary products account for over 80 percent of total exports in Africa during the past two decades. The direction of trade is towards the industrialized north with intra-regional trade low compared to total exports to other regions. Low inter-regional trade partly reinforces weak regional transport links and cross-country projects, energy inclusive. The dominance of primary products in regional exports and substantial transport problems explain the relatively low inter-regional trade. Fuel imports constitute a significant proportion of total imports in the region, consuming a substantial proportion of scarce foreign exchange. The current account balance position is shown in Table 4.

Eight, most countries are highly indebted and continually experience large net resource outflow to cover debt service. The debt stock almost tripled between 1980 and 1995. It rose from \$113 billions \$322 billion. The increasingly severe debt burden in Africa is show in the debt service rising from \$12.3 billion in 1980 to N32.5 billion in 1990 and \$26.4 billion in 1995.

Nine, the sectoral composition of national output reflects the dominance of agriculture and mining and the minor role of manufacturing in national production for most of the countries. In almost all the countries either or both of these sectors dominate the structure of gross domestic product. The manufacturing sector is relatively very small except for a few countries such as Egypt, Mauritius, South Africa and Zimbabwe. Overall, the data on the pattern and trends in economic structure during the period 1970 to 1995 support the hypothesis that there was no significant structural transformation in Africa. The picture that emerges is largely that of an economic structure that is almost static and highly dependent on stagnating agriculture and mining as the main income generating activities in the economy. Industry remained about one-fifth of GDP while share of manufacturing remained below 10 percent over the period. Mining and quarrying largely dominates value added in industry.



To sum up, the trends and patterns of economic and social development in Africa over the past two decades describe a development crisis of a magnitude unprecedented in its recent history. The sheer arithmetic of growth failure in Africa is overwhelming from these statistics. The consequence has been an alarming decline in living standards and social welfare. In marked contrast is the impressive performance of Botswana, and Mauritius. The collapse in real per capita income in the 1990s below the levels that obtained in the 1970s vividly captures the nature of the development crisis in much of Africa. In addition, continuing and deepening economic problems have substantially eroded the significant gains in social welfare in the immediate post-independence period. Furthermore, no significant advancement in industrialization beyond low level import substitution has occurred, and weak sectoral linkages continue to characterize these economies. Africa remains a low-income region with most of its population living in absolute poverty. This is in sharp contrast to typically moderate growth performance in the 1960s and 1970s. Overall, the social and economic profile defines difficult initial conditions for energy sector development and overall development process in Africa. These conditions include: a demographic profile and trend illustrated by one of the highest population growth rates in the world, low population density in most of the countries, low level of per capita income and industrialization and small economic size of each country that is inadequate to sustain any viable inward-oriented energy and economic development. Other initial conditions are less than robust economic recovery and sustained economic growth, economic fragmentation, social conflict, weak political institutions and governance, and a tougher international environment less receptive to international development assistance and debt relief.

### **3. Energy Resources, Production and Consumption**

#### ***Africa's Energy Resource Base***

Energy sources can broadly be grouped into two main groups, namely, conventional and the non-conventional energy sources. Conventional energy sources are of two types. These are renewable energy (hydroelectric and wood fuels) and non-renewable sources (coal, lignite, crude oil, natural gas and nuclear fuels). Non-conventional sources of energy in the region include solar energy, geothermal energy, biomass, oil shale and tar sands, wind energy and tidal energy from the sea.

The currently available information on Africa's energy resources is rather fragmentary and incomplete, due to low level of exploration and development of energy resources. This state of affairs has been the combination of relatively difficult domestic economic and political conditions and current demand and cost conditions in the global energy industry. However, from the available but rather conservative information, the African region is well endowed with a variety of conventional and non-conventional energy resources. Among these are crude oil, natural gas, coal, nuclear, tar sand, hydro-electricity, geothermal, biomass, solar, wind and other renewable energy resources. Africa's recoverable crude oil reserves in 1994 are estimated to be 10.5 billion metric tons or roughly 8 percent of the world's crude oil reserves (World Resources Institute 1997). Africa is third in regional ranking surpassed by the Middle East with about half the world's reserves, followed by

Latin America with 12 per cent. Natural gas reserves are estimated at 10.2 trillion cubic meters or 7.2 per cent of global reserves, making the Africa region the third in rank behind Middle East and Europe. As more exploratory and development activities continue in West and Central Africa, particularly offshore, more oil and gas discoveries are likely to be made. Africa's uranium deposits, estimated at 431,570 tons or 28.2 per cent of world reserves recoverable at \$80 per kilogram, are second largest after Australia. Coal reserves at an estimated 61.7 billion tons is 6 per cent of world reserves. Exploitable hydro resources of 1,589 GW represents about one third of the world's total hydro potentials. Renewable energy resources in the form of bio-energy and solar energy are widely available (Karekezi and Ranja; 1997). Wind energy potentials are also considerable.

Though the overall picture reveal availability of enormous energy resources which far exceed energy requirements of the region, most of these resources are grossly underutilized, particularly natural gas and hydro resources. Clearly, Africa's problem is not lack of energy resources but its efficient development and utilization. These resources are not, however, uniformly distributed among the countries.

The regional distribution of energy resources provided in Table 5 reflects significant sub-regional differences. Furthermore, the distribution of commercial energy resources is concentrated in a few countries. The Southern African region accounts for almost all the coal resources. South Africa alone accounts for 91 per cent of Africa's coal reserves. There is a sizable deposit of coal in Nigeria in West Africa. North Africa is dominant in oil and gas, followed closely by West Africa. Three countries namely, Libya, Nigeria and Algeria account for 84 per cent of Africa's proved oil reserves, with Libya alone having about 50 per cent of the African total. Algeria and Nigeria have between them 70 per cent of proven reserves of natural gas. Hydro resources are located mainly in Central Africa followed closely by Southern Africa. Congo DRC, Mozambique, Zambia, Cameroon, Ethiopia, Sudan and Nigeria have between them the bulk of Africa's hydro resources. Nuclear resources are located mainly in West and Southern Africa. South Africa and Niger account for 70 per cent of uranium resources.

**Table 5: Regional Distribution of Commercial Energy Resources in Africa 1993  
(Per cent)**

Sub-region	Coal	Crude Oil	Natural Gas	Hydro	Nuclear
North Africa	0.2	73.1	58.2	0.6	6.0
West Africa	0.4	16.2	34.5	7.5	36.9
Central Africa	0.1	3.6	2.9	45.4	4.5
East Africa	0.3	-	1.4	13.7	-
Southern Africa	98.9	7.1	3.0	32.9	52.6
AFRICA	100.0	100.0	100.0	100.0	100.0

*Source: Calculated from Data Table 12.3 in World Resources Institute (1997) World Resources 1996 – 1997.*

The uneven regional and country distribution of these conventional energy sources which point to substantial demand/supply imbalances, and the small size of most African economies, suggest that individual country strategy of energy sector development cannot be optimal from both individual country and regional perspective. However, it provides a strong argument for exploring more regionally focussed approaches to large-scale energy sector projects. A key challenge for sustainable energy development in Africa concerns the optimal utilization of the enormous renewable and non-renewable energy resources to facilitate sustainable human development in the region. North American and European gas and electricity networks provide relevant examples for the less economically endowed Africa

### **Overview of Recent Trends in Commercial Energy Production**

Production of commercial energy expanded by 29.7 percent from 408.7 million metric tons in 1980 to 530.1 millions tons in 1994. The share of Africa in global commercial energy production remained at about 7 percent during the period. Production in the region is dominated by liquid fuel, namely, crude oil (Table 6). In 1994, about two thirds of the total primary commercial energy came from crude oil. Oil and gas jointly constitute more than 75 per cent of primary energy production. Coal accounts for about one fifth of total production.

Table 6 shows the regional distribution of energy production between 1980 and 1994. Three key features of the table are noteworthy. One concerns the continued dominance of North Africa in energy production with almost 50 per cent in 1980 and 46.2 per cent in 1994. The second concerns the very low positions of East Africa in the current production structure. It is less than 1 per cent in both years. The third relates to the improving position of Southern and Central Africa, and the significant decline in the share of West Africa. Several factors account for the substantial variation in subregional energy production performance during the period under consideration. Among these are, energy resource endowment, the state of social and macroeconomic stability, fiscal arrangements in the sector and history of energy development.

**Table 6: Commercial Energy Production and Consumption Shares by Sub-region in 1980 to 1994 (in percent)**

Region	Consumption in 1980	Production in 1980	Consumption in 1994	Production in 1994
North Africa	32.3	49.8	40.1	46.2
West Africa	11.3	26.0	10.7	19.5
Central Africa	2.7	4.1	2.4	6.3
East Africa	2.9	0.1	2.5	0.2
Southern Africa	50.7	20	44.2	27.9
AFRICA	100	100	100.0	100.0

Source: United Nations Year book of Energy Statistics 1995.

## Oil and Gas

Oil and gas dominate the current structure of commercial energy production and consumption in Africa and this is expected to continue into the foreseeable future. Thus, it is useful to examine current domestic and international development in these two sub sectors in some detail.

African oil producers are major players in the world oil market and contributed almost 11 per cent of global oil production in 1997 (Table 7). Africa's share in world production has remained at this level for some years now. Africa continues to remain competitive in the global oil market. The three major African producers are Nigeria, Algeria and Libya who between them produce about two-thirds of the region's output. Nigeria remains Africa's largest oil producer. In 1997 it produced at almost full capacity averaging a little over 2 million barrels a day. With the rapid growth in oil production by more recent producers Equatorial Guinea, Congo, Chad, and South Africa – this share is set to rise in future. Total regional oil output rose by a robust 7 per cent over the 1996 level to reach 375 million metric tons in 1997. The newcomer Equatorial Guinea registered the most impressive performance. It's output more than doubled to reach 3.9 million tons. In Congo, output rose by about one third to reach 13.4 million tons. Most other countries registered more modest gains in production compared to the previous year. Nigeria, the largest producer, and Angola saw production increase by a decent 7 percent. In the second quarter of 1997, South Africa joined the league of African oil producers as crude oil began to flow from its field off the South Cape coast with a modest production of 20,000 barrels a day.

Foreign oil companies are finding the African region more profitable for oil exploitations than before as more competitive fiscal arrangements are increasingly being offered. This is reflected by the increased exploration and development activities of these companies in the region in recent years. For instance twelve new oil fields were discovered in 1996. In Nigeria greater upstream activities have been hindered substantially by the state oil company's severed budget constraints, making it unable to meet its joint venture investment obligations. The \$4 billion liquefied natural gas (LNG) project in Bonny (Nigeria) with an annual capacity of 7.2 billion cubic meters is expected to commence gas exports to Europe in 1999. The project is a joint venture between the state Oil Company and the multinationals, Shell, Elf and Agip. The LNG project continues to be plagued by several problems. The unnecessary delays in executing this project, including the stalled West African gas project to be fed mainly from Nigeria, have lost the economy much-needed revenues to supplement oil exports. They have also constrained the domestic and regional use of gas, but more importantly, weakened a potential dynamic source of economic growth to supplement oil exports. Nigeria is estimated to have more gas resources than oil. An oil and gas free zone was established at Onne-Ikpokin in the oil producing south east of the country.

Several foreign companies have signed oil and gas deals in Algeria. Most notable is an American company, Anadarko, which plans to invest \$1 billion to develop oil fields in the country. An important energy project is the 1250 kilometer Maghreb-Europe gas pipeline project, with a capacity of delivering 6 billion and 2.5 billion cubic meters per year to Spain and Portugal respectively by year 2000. Ultimately, 24 billion cubic meters of gas should flow from Algerian gas fields soon, further reinforcing the country's position as one of the world's leading producer and exporter of natural gas.

**Table 7: Oil Production in Africa and the World 1993 to 1997**

Country	1993	1994	1995	1996	1997b	Growth 1996-97 %	Growth 1995-96 %
Algeria	56.34	55.85	56.56	61.21	62.91	2.8	8.2
Angola	24.98	27.09	30.20	34.64	37.04	6.9	14.7
Benin	0.19	0.19	-	-	-		
Cameroon	6.34	5.80	5.38	5.10	5.16	1.2	-5.2
Congo	9.53	9.56	9.27	10.23	13.4	31.0	10.4
Egypt	44.20	45.50	44.80	45.32	44.34	-2.2	1.2
Equ. Guinea	0.23	0.23	0.34	1.71	3.9	128.1	408.9
Gabon	14.98	16.84	17.76	18.03	17.54	-2.7	1.5
Libya	67.87	67.92	68.64	67.74	69.88	3.2	-1.3
Nigeria	102.05	102.10	100.87	109.55	116.91	6.7	8.6
Tunisia	4.50	4.40	4.27	4.30	4.10	-4.7	0.7
Zaire	1.17	1.24	1.28	1.23	-	-100.0	-4.3
Total	331.90	336.72	339.37	350.70	375.18	7.0	3.3
Share	10.6	10.5	10.5	10.5	10.5		

Algeria's oil production has not been affected by the political crisis in the country. US sanctions against Libya have slowed down oil-related exploration and development activities. In Angola, the French Oil Company Elf, and its partners discovered a large new oil field with estimated reserves of above 3 billion barrels at Dahlia Field. A gas pipeline project connecting Panthere gas field to Abidjan was completed, Cote d'Ivoire's depends on imported fuel supplies for its electricity generation.

### Oil Prices

The world oil market in 1997 has not been as buoyant as in the previous year when demand pressures led to a substantial improvement in the price of oil, which reached \$20.42 on the spot market. Nevertheless, oil prices have been reasonably high as the average spot price of crude oil fell marginally to \$19.7 a barrel in the first quarter and \$18.4 in the second quarter of 1997. It is expected that the average price for the year would be around \$18.5. The increased downward pressure on crude oil expected from the flow of Iraqi oil to the market did not fully materialize due to the breakdown of the United Nations-brokered oil-for-food and drug deal.

The long term price prospect is however not very promising despite the recent price gains and a moderate 2 percent growth in world oil demand for two major reasons. The first concerns the 10 percent increase in OPEC production quota to 27.5 million barrels a day agreed upon by member countries in December 1997. Market reactions to this development have been negative leading to the lowest crude oil prices in the last two years. The rise in OPEC crude oil supplies, coupled with the impact of mild winter associated with the El Nino phenomena in the major oil consuming countries exerted further downward pressures on prices in 1998. The second factor concerns the impact of new and advanced technologies on the global search for oil and the increase in crude oil supplies

that will ultimately follow. This has made the discovery and extraction of new oil much cheaper and reserves of oil increasing rapidly. The oil market will have to cope with these challenges in the future. This is an important issue for Africa as some of the most important economies in the region are major oil producers and substantially dependent on oil exports.

### **Electricity Production**

Electricity generation in Africa in 1994 was 350,000 Gigawatt-hours, representing a percent growth since 1980. The generation mix is dominated by fossil fuel generating plants accounting for 81 percent of total electricity generation with hydro coming a distant second with 15 percent. Oil-based generation is more uniformly distributed in Africa. Coal-based generation feature prominently in the southern African countries of South Africa, Zimbabwe, Botswana, and Mozambique. Morocco in North Africa and Niger in West Africa also use coal to generate electricity. Gas fuelled plants are increasing in importance in Algeria, Nigeria and Tunisia. Nuclear and geothermal are relatively unimportant at 2.7 and 0.1 percent respectively. Kenya remains the only country exploiting its geothermal resources, but progress in this direction remains lackluster. Installed capacity is dominated by fossil fuel. Only a fraction of available hydro resources is utilized due mainly to: shortfalls in waterflow associated with climate change in some countries, low demand in countries endowed with immense hydro resources, potential losses associated with long distance transmission from countries endowed with immense hydro resources to energy deficient countries and regions. The average sub-regional load factors range from 65 percent in East Africa to 70 percent for North and West Africa and 75 percent for Central and Southern Africa.

Of particular importance in Africa is the high plant reserve margins, which suggests that a significant proportion of installed power plant capacity have low operational performance rating. This combined with the large transmission and distribution losses in the region point to inefficient and expensive supply network. Both of these problems have been documented in the recently published ADB African Energy Report (1996).

North Africa accounts for about one third of Africa's electricity production based largely on burning oil supported by coal and natural gas. West Africa's share of 9 percent is based on a mixture of hydro, oil and gas. The share of Central Africa is 4 per cent dominated by hydro and East Africa with 3 percent consists of mixture of oil and hydro. Southern Africa produces the largest share of Africa's electricity production. It constituted 55 percent of the regional production. Hydro and coal-burning generating plants dominated the structure of South African electricity production.

### **Overview of Recent Trends in Energy Consumption**

Primary commercial energy consumption in Africa in 1994 was 218 million metric tons of oil equivalent. Oil and gas accounted for 62 percent of the total, and solid fuel 35 percent (Table 8). The remaining 3 percent were hydro and geothermal energy. Over the period 1970 to 1994 the share of solid fuel consumption declined while natural gas showed the greatest gain with its share rising from about 1 percent to 21 percent of total consumption. Hydroelectric and geothermal share

**Table 8: Primary Commercial Energy Consumption in Africa by Fuel Type for Selected Years 1980 to 1994 (in Percent)**

Year	Total	Solid	Liquid	Natural Gas	Electricity
1970	100.0	46.1	50.0	0.7	3.3
1980	100.0	33.8	53.4	8.9	3.9
1990	100.0	35.9	42.8	17.8	3.6
1994	100.0	34.9	41.1	20.6	3.3

remained almost static. The low share of hydroelectricity reflects the underutilization of this source of energy due to huge financial resources needed to construct hydroelectric projects in areas where the resources are located, the distances from the supply sources and the demand areas, and increasing water flow problems confronting hydroelectric dams in the region.

Commercial energy consumption in Africa slowed down in the first four years of the 1990s growing at 2.2 percent compared with 2.6 percent between 1980 to 1990. This is in line with the global trend which saw demand fall sharply from 5 percent to 0.5 percent. The growth in commercial energy production exhibits varied sub-regional and country performance (see the appendix). The Central African region more than doubled its growth rate whereas the other four regions registered lower growth that ranged from 0.7 percent in the West African region to 2.8 percent in North Africa. Energy consumption remained almost static in west and southern Africa between the two periods but declined significantly in North and East Africa. Just as the growth experience reveals a mixed sub-regional pattern so also does the country experience. Six countries, Morocco, Nigeria, Gabon, Tanzania, Congo Brazzaville, Mozambique and Zambia showed significant improvement in consumption rates while five countries experienced deterioration. Most countries experienced a considerable reversal in the trend of commercial energy growth trend between 1990 and 1994 compared with the 1980-1990 period. Among these are South Africa, Algeria, Egypt, Zimbabwe, Sudan, Ethiopia, Uganda, Senegal, Central African Republic, Botswana, and Mauritius. Overall, the slowdown in the growth of energy consumption reflects the joint impact of higher domestic energy prices associated with higher import costs and currency devaluation (as imported oil dominates the structure of commercial energy consumption in most African countries), and slowing of economic growth.

Two key points emerge from a sub-regional insight into Africa's energy consumption structure. Southern Africa remains the dominant sub-region with energy consumption accounting for 44 percent of the total in 1994, though this meant a decline from the 51 percent share in 1980. It is closely followed by North Africa, which improved its share from 32 percent in 1980 to 40.1 percent in 1994, East, and Central Africa remained at the lower scale of the consumption ladder.

Electricity consumption increased by 112 percent over the 1970-1980 period by 71 percent between 1980 and 1990 and by 10.2 percent in the 1990 to 1994 period. African regional trade in electricity in 1992, the last year for which data is available, stood at a low level of about 3 percent. Trade in electricity is more prominent in Southern and Central Africa where it reached 22 and 12 percent respectively in 1992. It is lowest in North Africa at 1.4 percent, followed by 4.3 percent in West Africa, and 5 percent in East Africa.

Also of interest is the trend in energy import dependence in African economies. In 1980 regional commercial energy production exceeded consumption by a ratio of three to one. However, the production-consumption ratio fell to two to one by 1994. Two factors accounted for the decline. One was the rising domestic consumption driven by the requirements of economic development. The other was the decline in the output of three leading net energy exporting countries Algeria, Libya and Nigeria (all members of OPEC) associated with their OPEC production quota allocation in line with OPEC's effort to check excess supply from depressing prices to the point of collapse which occurred in 1986.

Though the African region remains on the aggregate a net energy exporter, there are significant disparities at the country level. For instance, only eleven of the countries are net energy exporters with the majority of the countries being net energy importers both in 1980 and 1994. The main exporting countries are of Libya, Gabon, Nigeria, Congo Brazzaville and Angola. Net energy export increased in three countries, Angola, Gabon and Cameroon. Two countries Tunisia and Mozambique switched to become energy countries. Benin became a net energy exporter.

To put the African energy problem in global perspective, the share of Africa in world energy consumption is about three per cent which reflects the region's relatively low level of economic development and greater use of traditional energy within a basically rural-dominated economic structure. On a per capita basis, energy consumption estimated at 2635 megajoules is low in Africa. In 1994, it was 19 percent of the world's average, 6 percent and 4 percent of the average consumption in Europe and North America respectively. Per capita electricity consumption at 494 kilowatt-hours was 22 percent of world total in 1994, 5.5 percent of North America, 3.9 percent of the US, 48 percent of Asia and 29 percent of Latin America.

### ***The Pattern of Energy Use in Africa and the Role of Traditional Fuel***

Total primary energy consumed is made up of biomass-based and commercial energy. Table 9 provides a broad perspective on the aggregate energy use pattern in the region according to countries in 1980 and 1994. The data indicates a highly skewed consumption pattern with 65 percent of total energy use made up of biomass (woodfuels). The dominance of traditional fuel in total energy use mix in Africa is explained by factors such as: the significant share of peasant-based agricultural production in national output the large proportion of the rural population, and the low income of the bulk of the population.

The trend in consumption of traditional fuel deserves special attention, given the problems associated with deforestation, desertification and the impact of overdependence on traditional (woodfuel) energy use on environmental degradation. There is some evidence of a noticeable decline in the rate of growth of woodfuel consumption in the several countries in the region compared to the past. However, the share of traditional fuel in energy consumption, which remained unchanged at about 65 percent between 1980 and 1994, raises some concern. Several countries have traditional energy share far in excess of the region's average as is evident in one out of four countries with shares above 85 percent. The most prominent is Benin, Burkina Faso, Ethiopia, Tanzania, Central African Republic, Chad and Uganda. With the exception of Sudan, North African countries use



**Table 9: The Share of Traditional Fuel in of Total African Energy Use 1980 and 1994**

Region	1980	1994	% Change
North Africa	7.0	5.4	-21.9
West Africa	70.8	73.3	3.6
Central Africa	74.7	66.9	-10.5
East Africa	87.3	86.3	-1.2
Southern Africa	63.3	65.0	2.7

Source: World Bank (1997) World Development Indicators.

low amount of traditional fuel. Algeria's share of about 2 percent is the lowest while the highest is Tunisia with 13 percent. Central and East Africa are more users of traditional fuel than the other regions though more countries in central Africa have showed much wider reduction in their use of traditional fuel than other sub-regions.

#### **4. Policy and Institutional Constraints to Energy Sector Development**

A major constraint to efficient energy development in Africa is the low priority given to energy efficiency and resource allocation issues in domestic debates, especially in much major net oil exporting economies. These issues are often submerged by the perception that oil is a political good, and sharing the oil cake must imply cheap domestic fuel. Oil and gas are unique resources because they are depletable assets whose long run scarcity must be properly considered in order to ensure their efficient use in the long term. Oil and gas producing countries have three options for the use of their oil, namely, domestic use, export, and conservation for future use. Efficient allocation among these three options depends on the opportunity cost of oil in each use. The marginal net benefit from each use must be equalized for efficient use of the oil.

Policy reforms based on the fundamental economic principle of opportunity costs stress the need for the separation of allocative and distributional objectives in the energy market and using policy instruments that have comparative advantage in achieving either objective efficiently. Prices have comparative advantage in achieving efficient resource allocation while taxes and direct income transfers, rather than price subsidies, are more efficient tools for achieving distributional objectives. The thrust of economic policy reform should be to properly balance economic and social objectives. However, the socio-political repercussions of dramatic policy reversal in a depressed economy should not be underrated as the policy reform experience of recent years in many countries demonstrate. In this regard there is need for caution in implementing severe shock-prone policy changes which could inflict very high short and medium term adjustment costs on the economy

because of the way such policy changes are implemented. Fundamental reforms, which are hastily implemented under crisis condition without sufficient preparation, impose unnecessarily high cost on the economy in terms of output losses and reduction in living standards. In addition the cost-push and output deflation effects of a more liberalized energy price policy and market environment must not be under-estimated in a depressed economy. The lack of policy stability and consistency compounds the problem too.

Fuel prices that accompany energy market deregulation and encourage more efficient use of energy are important in the effort to reduce fuel-related environmental damage. Deregulation that brings about significant pricing reform is an indispensable requirement in correcting maladjustments in the energy market. However, the important role of energy market liberalization would be undermined if the institutional framework to support such liberalization were grossly inadequate. More effective liberalization of the energy market inclusive of commercialization/privatization of state owned enterprises will help to improve production efficiency, enhance overall efficient allocation of economic resources and boost economic growth. An additional consideration that is non-price related is the need for less government intervention in the management of the oil sector to enhance productive efficiency of state oil companies that dominate the sector in Africa.

Energy pricing policy should be grounded on three basic principles. First it should allow the oil company to cover its production and delivery costs including its replacement investment, and guarantee a rate of return no less than what other producers in the replacement investment, and guarantee a rate of return no less than what other producers in the economy can obtain with comparable degree of risks. Secondly, the relative price structure should encourage efficient inter-fuel competition in the energy market e.g. kerosine-fuel wood, liquified petroleum gas (LPG)-kerosine, LPG-fuelwood, oil-coal, natural gas-diesel, natural gas-residual fuel oil. In essence, petroleum products pricing policy must be viewed in a more global energy pricing perspective. Thirdly, oil prices should be allowed to perform their allocative function, which implies that they reflect the marginal benefit in the next best use. Allocative efficiency would induce greater efficiency of oil use and the associated economic efficiency gains. Ideally this suggests that pricing should not be saddled with equity objectives. Taxes and direct income transfers in contrast to price subsidies are more appropriate for the latter objective of social and regional equity.

Fragmented institutional framework for energy and oil decision making constitute another major obstacle to efficient energy development in the region. The institutional infrastructure for formulating and guiding energy policy in the region needs overhaul in the more liberalized energy markets that are emerging. A pricing regulatory and monitoring agency needs to be established to take care of consumer's interest in pricing petroleum products.

Clearly both market and non-market forces will continue to shape the energy market. However the key issue concerns the balance of the two and particularly the quality of government intervention in the energy market. The optimal (efficiency oriented) solution is for market forces to predominate. The broad rationale underlying this proposition is that it is in the long run the least costly and more sustainable option for improving the welfare and living standards of the population and overall socio-economic development. Evidently, as long as energy remains a key factor in social and economic development there would be government intervention.

In conclusion, increasing the role of the market in the energy sector would not necessarily imply total elimination of government intervention in the market. While it is widely agreed that market considerations would be given greater weight in energy policy, the role of the government would still be significant. For example, the current strong pressures for a cleaner environment in the developed countries would further redefine the balance between the market and the government in the energy sector and the economy. This is due to the energy sector being a major source of environmental degradation. The attempt of some developed countries to impose carbon taxes on fossil fuels, particularly oil, is a case in point. In any case, the controversy on this tax continues just at government involvement in the energy sector. However, what is clear is that the quality of policy intervention is likely to be superior to what obtained in the past. The wider role of public policy should be to enhance an efficient blend of market forces and government intervention that seeks to achieve more than what many critics of economic adjustment particularly in developing Africa has described in recent years as often narrowly defined national economic goals and objectives embodied in such measures as deregulation and privatization and structural adjustment.

## **5. Towards an Agenda for Sustainable Energy Development in Africa**

The potentials for efficient energy use pattern and ultimately achieving sustainable energy future are great, provided a number of problems identified earlier are effectively dealt with. In terms of designing approaches and policies to deal with the challenges of sustainable energy development, in the overall context of sustainable human development, a variety of policies and other measures are suggested below.

- Policy interventions must encourage more efficient allocation of resources. Improvement in energy use pattern can only be sustainable when it is carried out in the context of a general improvement in the utilization of other productive resources.
- Policy interventions that correct market and government failures, which have encouraged inefficient energy use patterns. Such are evident in choices involving the construction and use of residential and public buildings, agricultural and industrial machines and equipment, and other capital stock. The market environment must be sufficiently free such that consumers can economically trade off energy costs against service quality without policy induced distortions.
- Capacity building in research and development that promotes the choice of economically and environmentally efficient energy use patterns (Box 1). Training programs and workshops that would bring together public officials, industrialist, farmers, environmentalists, economists, sociologists, scientists, architects and engineer's on making efficient choices concerning energy use in the context of locally relevant, economically efficient and environmentally sustainable way must be actively pursued.

**Box 1: Energy, Environment and Development in Africa**

The importance of the energy environment-development issue in the debate on sustainable human development concerns the prominence of energy use in local, national, regional and global environmental degradation processes and its attendant adverse effects on human health and the environment.

Although energy use is fundamental to economic growth and social progress, the large increases in the burning of fossil fuels to provide energy services have been identified as a major factor in the build-up of greenhouse gases (GHG) in the atmosphere which are posing a serious threat to the ecological balance through global warming.

The international conference on global warming which took place in Kyoto in December 1997 had 159 countries in attendance. This latest global effort to stem the accumulation of GHG and global warming prompted 34 countries from the richer developed world to agree to curb their GHG emissions, the US by 7 per cent and the European Union by 8 per cent not later than year 2012. No limits were imposed on the developing world mainly due to what they require to further their social and economic advancement from their current relatively low level.

Providing the considerable amount of energy services required to meet basic human needs of an increasingly urbanized population, and to fuel higher and sustained economic growth from its current low level, implies using a larger and rising amount of commercial energy in African countries. The fundamental issue is not whether more energy would be used but how efficiently and at what social (inclusive of environmental) costs to ensure that the development process is sustainable. Compared with other regions, the low income African region is largely characterized by energy-inefficient and pollution-intensive technologies of production and consumption.

Mitigating the negative environmental externalities of energy development in an economic environment where poverty is widespread certainly poses complex social and economic problems. For instance, the large scale importation of used and energy-inefficient and more polluting electrical and transport equipment into many African countries which is symptomatic of their weak economic conditions will exacerbate their energy-environment-development conflict.

Africa's current complex energy-environment-development situation arises for several reasons. One involves the ageing capital stock, which is underscored by weak investment activity and is associated with poor economic growth performance of the post-1980 period. This impeded increased adoption of more energy and other input-efficient and cleaner technologies that embody newer processes. Another concerns the past administratively-determined energy prices which most often did not reflect the opportunity cost of energy supply to the end users in most African countries. This precluded them from realizing the impressive gains in energy efficiency and use patterns particularly in major energy-consuming sectors of industry, transport and households. Also, and almost peculiar to Africa is the poverty-induced overdependence of household energy use on inefficient burning of biomass fuel. It is estimated that energy used for cooking by the African housewife is four to five times that of her counterpart in the developed world (Churchill, 1993). The income-constrained access to more energy-efficient and newer electricity or gas-based cooking equipment continues to exacerbate energy-environment-development conflict in the region.

Though African countries currently contribute insignificantly to global GHG emissions through their energy use, reducing waste in African energy use and improving the efficiency of energy use is not only economically valuable but also environmentally desirable. Important elements in Africa's effective participation in the global quest for better environmental quality and ecological balance are: the strengthening of market-based energy prices; the spreading of the culture of better energy management reinforced by higher and sustained economic growth; a substantial increase in joint regionally-based investments in energy-efficient and environmentally cleaner technologies and capital stock in the currently fragmented energy markets; and better utilization of its abundant renewable energy sources.

- Transport fuel demand constitutes the dominant share of commercial energy use pattern. A policy that correct the investment distortion in the sector coupled with more economical road pricing that makes drivers pay the social (inclusive of environmental) costs of road use is highly desirable and must be pursued. The enormous economic and environmental damages associated with heavy trucking on the highway and the air pollution in the urban areas caused by traffic congestion and poor vehicle maintenance by other vehicles would only be significantly addressed when investment in viable alternatives by rail and water transport are seriously considered. Rail development must be a priority especially as the stock of vehicles decline at a rapid rate. Putting an 8 to 10 year age limit on imported used vehicles would reduce the excessive fuel consumption and environmental pollution that had accompanied their indiscriminate imports in recent years. The vehicles of the 1990s embody greater fuel efficiency and are environmentally safer than older vehicle stocks, which are imported in to several African countries.
- Since most African consumers have higher discount rates than the government because of their lower risk preferences, the government should be more risk taking in supporting innovative but economically and environmentally appropriate energy alternatives in the rural areas where the bulk of the population that depletes the forest lives. This is also appropriate in the urban areas as well as. Greening the economy in this way would encourage energy end users to explore these alternatives with less trepidation. Effective implementation through infrastructure provision and consumer education has been lacking. Correcting these defects would produce positive results.
- Financing and other incentive schemes are important in this regard. Demand side efficiency is considerably cheaper than the expansion of supply facilities and this should be pursued more vigorously.
- Policy reforms should focus on encouraging a level-playing field for all energy forms in terms of internalizing the environmental and economic costs of different energy types. An appropriate energy pricing structure is fundamental to the emergence of a sustainable energy future in Africa.
- Improvement in the performance of electricity supply would affect energy use pattern as those who have to use more expensive alternatives would be save the costs. The air pollution effects of innumerable generators producing captive power to meet the demand for electricity by consumers are considerable. Such an improvement would involve redefining the role of the government and the private sector in the provision of energy. In particular, it must involve major improvements in the production and delivery of electricity, petroleum and other energy products to end-users.
- The culture of energy management (of which energy audit is a key component) to improve upon energy efficiency must be widely encouraged and vigorously pursued by more and

more business enterprises in the region. More efficiency oriented scheduling maintenance and servicing of equipment, waste reduction and recycling, and retrofitting would significantly reduce waste in energy using activity. It is suggested that up to a quarter of current energy use can be dispensed with in many firms with effective energy management. Recent increases in energy prices should help many enterprises and major consumers to be more rational in their use of energy services.

- The establishment of an energy information system that encompasses aggregate, sectoral, spatial and environmental aspects of energy development sustained by private-public cooperation to support the dissemination of information and adaptation of energy-efficient and environmentally friendly technologies in both urban and rural areas.
- Stronger emphasis on a more integrated energy supply network, based on more widespread regional initiatives, particularly in gas and electricity, as obtains in such other regions as Europe and North America, is essential to sustainable energy development in Africa.

## 6. Conclusion

Though the overall picture reveal availability of enormous energy resources which far exceed energy requirements of the region, most of these resources are grossly underutilized, particularly natural gas and hydro resources. It suggests that Africa's problem is not lack of energy resources but its development and utilization. The region will remain a major net exporter of energy for several decades to come. In dealing with its energy problems Africa faces a unique set of initial conditions, defined mainly by its level and pattern of economic growth, social and demographic characteristics, energy resource endowment, location distances between supply sources and consumption areas, technological underdevelopment, and poverty-driven energy-environment conflict. A key challenge is the optimal utilization of the region's energy resources to facilitate both individual country and regional energy and economic development. Stronger emphasis on a more integrated energy supply network based on more widespread regional initiatives, particularly in gas and electricity, and as currently obtains in some of the sub-regions (Southern Africa), is essential to sustainable energy development in Africa. The substantially higher costs of electric power and petroleum products in Africa compared to other regions a negative factor that undermines the region competitiveness in international market. The relatively small size of many of the economies suggests that more forceful regional initiative merit greater attention. The ADB is rightly placed to be a catalyst in this regard. The key issue for the African region is how to cope with the immense task of providing and securing adequate, reliable supply of cleaner energy to meet the requirements of a growing population and economy in an affordable and efficient way. This is a task that must be faced squarely and timely too particularly given the magnitude of Africa's energy problems and the fact that the current energy infrastructure of many countries in the region is inadequate to support the rapid economic growth required to substantially raise the living standards of the people.

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